

These lists collectively furnish the final column (Q) of the Distribution Table.

POLYZOA.

A few of the soundings contained specimens of Polyzoa in more or less fragmentary condition. These have been identified by my good friend the Rev. A. M. Norman as follows:—

- No. 500. *Menipea arctica*, Busk.
Crisia eburneo-denticulata, Busk.

In this sounding, and also in No. 516, there are examples of a very interesting simple form, the type of an undescribed genus.

- No. 514 a. *Idmonea atlantica*, Forbes.
Crisia eburneo-denticulata, Busk.
 No. 515. *Crisia eburneo-denticulata*, Busk.
 No. 525. *Lepralia Jeffreysii*, Norman.
Idmonea atlantica, Forbes.
Hornera lichenoides, Linné.

EXPLANATION OF PLATE XXI.

- Fig. 1. Haplophragmium nanum*, Brady, magnified 120 diam.: *a*, superior lateral aspect; *b*, inferior lateral aspect; *c*, periphero-lateral aspect.
Fig. 2. Reophax arctica, Brady, magnified 120 diam.: *a*, lateral aspect; *b*, end view, with aperture.
Figs. 3, 4. Hippocrepina indivisa, Parker, magnified 60 diam.: *a*, lateral aspect; *b*, end view, with aperture. 4. Section, showing the interior.
Fig. 5. Nonionina orbicularis, Brady, magnified 65 diam.: *a*, lateral aspect; *b*, periphero-lateral aspect.
Fig. 6. Discorbina Wrightii, Brady, magnified 85 diam.: *a*, superior lateral aspect; *b*, inferior lateral aspect; *c*, periphero-lateral aspect.

XLI.—On certain Points in the Morphology of the Blastoidea.

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SINCE the appearance of the classical memoir by Römer scarcely any attention has been paid upon this side of the Atlantic to the morphology of the Blastoidea. In America, however, the case has been very different. White, Shumard, Billings, Lyon, Hall, Meek and Worthen, and various other

writers have all added more or less to our knowledge of this interesting but difficult group. Although some of their conclusions have not borne the test of further investigation, yet their observations have been mostly confirmed by later workers, while their descriptions of them are clear, accurate, and scientific. Two other palæontologists have recently taken up the subject, and have treated it in very different ways, as I propose to show in the following pages.

Mr. Charles Wachsmuth, of Burlington, Iowa, who is so well known by his writings on the Palæocrinoids, has published incidentally, in the revision of that group by himself and Mr. Springer, some extremely valuable notes on the structure of the Blastoids, which are illustrated by excellent diagrams*. The chief novelty discovered by him is the presence in *Pentremites* of a plate lying directly below the lancet-piece, with a tubular passage running through it. He does not, however, either describe or figure any perforation of the lancet-piece itself; and in the case of *Granatocrinus* he merely figures one subambulacral † plate, pierced by a longitudinal canal.

Dr. Hambach ‡, on the other hand, figures a section of a ray (of *Granatocrinus Norwoodi*?), the lancet-piece of which is not only "pierced through the centre in its whole length by a very fine canal," but also has a posterior (*sic*) side which is "concave, semilunar, and grooved in its whole length for the reception of some duct or vessel." At the summit this duct or vessel "connects with a circular duct (œsophageal ring?), surrounding, on the interior side, the central orifice or *annulus centralis*." Thanks to the kindness of Mr. Wachsmuth, I have been enabled to examine many beautiful internal casts of *Granatocrinus Norwoodi*, a well-preserved specimen of which is the original of Dr. Hambach's description; but, despite this advantage, I am at a loss to understand his

* Part I. of the "Revision of the Palæocrinoidea" appeared in the 'Proceedings of the Philadelphia Academy' for 1879; and Mr. Wachsmuth has been good enough to favour me with advance sheets of Part II., which will be issued shortly. In this valuable work the authors have reduced the chaos of the Palæocrinoids to something like order; and the illustrated memoir, of which it is but the precursor, will be heartily welcomed in Europe, as it is utterly impossible to gain clear ideas about many of the American species, owing to the difficulty of obtaining the literature on this side of the Atlantic.

† I use this word simply to denote the parts beneath the food-groove, without thereby implying any homology with similarly-named structures in the Echinozoa.

‡ "Contributions to the Anatomy of the Genus *Pentremites*, with Descriptions of new Species," Trans. St. Louis Acad. vol. iv. no. 1, pp. 145-160.

meaning, and can only hope for a further explanation of it in his forthcoming monograph.

An extensive series of observations which have been made conjointly by Mr. R. Etheridge, Jun., and myself*, enables us to give a general confirmation to the results of Wachsmuth and Hambach. We cannot with certainty detect more than one subambulacral plate in any species of *Granatocrinus*, either British or American; but we cannot agree with Wachsmuth in considering its longitudinal canal as corresponding to the dorsal canal of a Crinoid arm, which lodged the axial cord; for we believe it to have contained the water-vessel. We think, however, that he is correct in describing two subambulacral pieces in *Pentremites*; but we are not quite clear as to whether both of these were perforated, or only one, and if so, which of them. It is a matter of no little difficulty to attempt to solve problems of this kind on material which is so highly mineralized as most of these Blastoid calices are; and it is therefore satisfactory to find that the observations of three independent sets of workers are fairly in accordance with one another.

Besides the lancet-piece and the poral pieces, there is, according to Dr. Hambach, another element which enters into the composition of the ambulacra of the Blastoids, viz. "the zigzag plicated integument. This may be regarded as a band which is transversely plicated and covers the whole ambulacral field; it was probably of an elastic texture during the lifetime of the animal. It commences at the apex of the ambulacral field, running in a zigzag from the lateral margin to the median line, so that the poral openings are always placed between two returning folds, which are flattened here to form a sort of articulating surface for the pinnulæ. It ascends in this manner, covering half of the ambulacral field, to the summit of the calyx, where it surrounds in a very acute angle two of the ovarian openings, and descends in a like manner on the following ambulacral field."

Two figures are given by Dr. Hambach in illustration of the novel statement which I have quoted. One of them represents a portion of an ambulacral field considerably magnified; and in some points it is more correct than any which has yet been published. Thus the pinnule-sockets are shown to be distinct from the marginal pores, as was long ago described, though not figured, by Billings †, whose observa-

* "Remarks upon the Structure and Classification of the Blastoidea," 'Nature,' vol. xxiv. p. 497, and Geol. Mag. October, 1881, p. 464.

† 'Canadian Naturalist,' 1870, p. 184.

tions seem to have escaped the notice of both Wachsmuth and Hambach. The other figure, published by the latter author, professes to represent the summit of *P. sulcatus*, and, though small, is clear enough to show that the "zigzag plicated integument" which passes round the ovarian openings from one ambulacral field to the other is nothing but the crenulation on the central ends of the deltoid pieces. This is excellently shown in Römer's figures of *P. crenulatus* *, and also its continuation up onto the lancet-piece along the margins of its median groove. In all the best-preserved specimens of *Pentremites* that I have seen, the edges of the minute transverse grooves on the ambulacral fields, which join their median grooves alternately on opposite sides, are also crenulated, as is shown in Dr. Hambach's figure. But the markings are not due to the presence of any probably elastic "integument" overlying the plates, as Dr. Hambach seems to suppose, as they are merely delicate surface-ornamentation. In the case of the lancet-plate of *Granatocrinus* this is very well seen on ambulacra from which the pore-plates have disappeared; so that the contrast between the crenulated edges to the median groove of the plate and its smooth peripheral portion is very marked.

It is very singular that, although Dr. Hambach has "had an opportunity to study a large and excellent material . . . numbering several thousand specimens in almost every stage of preservation," he does not make the slightest mention of the minute plates which have been described by so many authors as covering in the ambulacral furrows of the Blastoids. He is less reticent, however, about the so-called summit-plates, which are generally supposed to have roofed in the peristome, and to represent on a small scale the vault of the Palæocrinoids. For he says that the acute points of the zigzag plicated integument, "which almost come in contact with each other at the summit, are the only covering of the central opening, which was never closed by additional plates, as intimated by some authors †; although specimens are frequently found (and I have such in my collection) where it appears as if the summit were closed by additional plates, which on close examination, however, prove to be Bryozoa or ovulum-like bodies. Again, it seems improbable to suppose that the central opening was closed if we compare our fossils with *Echinoderms*, with which they have unquestionably most affinity, both as regards the calcareous shell as well as the interior of

* Wiegmann's Archiv, Jahrg. xvii. Band i. fig. 15 (1851).

† Billings and Shumard.

the visceral cavity (except as regards the number and arrangement of pieces)."

One scarcely knows how to criticise the remarkable statements contained in the passage just quoted. For myself, I should greatly like to learn something more about the evidence which satisfied Dr. Hambach that the structures in question are "Bryozoa or ovulum-like bodies." If they be Bryozoa, they must certainly represent a most aberrant type of that group, and it would be well worth Dr. Hambach's while to investigate and describe them. If, on the other hand, they are "ovulum-like bodies," one would like to know more about the "ovulum" which they resemble. Does Dr. Hambach mean to suggest that they are partially hatched "ovula" of the Blastoid?

After Dr. Hambach's astounding statements about the summit-plates of the Blastoids, his remark that this group has "unquestionably most affinity" with Echinoderms falls rather flat, as I am not aware that any one has ever proposed to consider these fossils otherwise than as members of that subkingdom. As a general rule, too, the nearest allies of the Blastoids have been sought for among the Crinoids. But, according to Dr. Hambach, the affinity of the Blastoids with Echinoderms "can easily be comprehended if we divide the calyx into two equal halves, *i. e.* an upper or dorsal and an under or ventral one, of which the ventral one would be composed of the pelvis and fork-pieces, and the dorsal one of the deltoid pieces and ambulacral fields. Supposing the column to be absent, we would have an analogue of an *Echinus*, except that mouth and vent are placed, together with the ovarian openings, on the dorsal part of the shell instead of being on the ventral side, as in true Echinoids."

I must confess that I cannot easily comprehend the advantage of inverting the generally received nomenclature in such a manner as to place the mouth and vent of a Blastoid on its dorsal side; and when this is done and the column supposed to be absent, I altogether fail to see the analogy between the Blastoids and the (true) Echinoids, in which last group Dr. Hambach admits that the mouth and vent are on the ventral side. Even if I am right in supposing that the word "Echinoderms" in the passage quoted above should be read "Echinoids," I am unable to see the affinity between this group and the Blastoids, "both as regards the calcareous shell as well as the interior of the visceral cavity (except as regards the number and arrangement of pieces)." If the pieces of the calcareous shell in the two groups do not agree in number and arrangement, I should be glad to know the characters wherein